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IN-VITRO EVALUATION OF PLANT LEAF AND OIL CAKE EXTRACTS AGAINST RHIZOCTONIA SOLANI CAUSING FRENCHBEAN ROOT ROT DISEASE

KUMAR. M, KUDADA. N, SAURABH. A & ZEESHAN. N

Department of Plant Pathology Birsa Agricultural University, Ranchi, Jharkhand, India

ABSTRACTS

In the present study, effects were made to explore the efficacy of various plant leaf and oil cake extracts against Rhizoctonia solani. Efficacy of eight leaf extracts viz., Neem (Azadirachta indica), Karanj (Pognamia pinnata), Bakain (Melia azadirachta), Datura (Datura stramonium), Bael (Aegle marmelos), Eucalyptus (Eucalyptus obliqua), Sindwar (Vitex negunda), Marigold (Tagetes erecta) at 10 and 20 percent concentrations and nine oil cake extracts viz., Niger (Carthanus tinctrorius), Neem (Azadirachta indica), Soybean (Glycine max), Mustard (Brassica compestris), Linseed (Linum usitatissimum), Sesamum (Sesamum indicum), Karanj (Pongamia pinnata), Groundnut (Arachis hypogaea), Mahua (Madhuca indica) at 5 and 10 percent concentrations were evaluated by using poisoined food technique in-vitro condition and recorded the radial growth of the mycelium. The neem (A. indica) leaf extract recorded maximum mycelial growth inhibition by 66.87, 54.12 percent after 4 and 7 days incubation, respectively at 10 percent concentration and 98.17 and 74.58 percent after 4 and 7 days incubation, respectively at 20 percent concentrations. Maximum mycelial growth inhibition by 64.15, 66.48 percent after 4 and 7 days incubation, respectively at 5 percent concentration and by 81.84, and 64.97 percent after 4 and 7 days incubation, respectively at 10 percent concentration was recorded with neem oil cake extracts (A. indica). The present study revealed that neem leaf and oil cake extracts could be explored for the possible control of deadly pathogen R. solani.

KEYWORDS: In-vitro, Plant leaf/ oil cake extracts, Rhizoctonia Solani & Frenchbean

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Original Article

INTRODUCTION

French bean (*Phaseolus vulgaris* L.), is one of the most important leguminous crops grown throughout the world. It belongs to the family Fabaceae, which is also known as kidney beans, haricot bean, snap bean and Navy bean. In India, the fresh pod used as vegetables are called, fresh bean and the dried pod for pulse is called Rajmah. The crop French bean is affected by many fungal, bacterial, viral and nematode diseases. Among fungal diseases, root rot caused by *R solani* is most destructive and occurs at pre- and post-emergence stage of seedlings and causes significant losses in yield. *Rhizoctonia* rot of carrot, etc. *Rhizoctonia solani* Kuhn causing root rot disease is a soil inhabitant, polyphagus and a facultative parasite. It is known to cause disease in many crops including rice, barley, urdbean, soyabean, potato etc. (Upmanyu *et at*., 2002). This pathogen causes a variety of symptoms, like crown rot, sheath blight, web blight, root rot etc. on different hosts. The yield losses from this disease have been reported 8.5 to 64.7 % from Bangalore (Sharma and Sohi, 1980), though the fungus is seed borne and soil borne. Soil-borne inoculum is more important in causing infection and disease development. Plant extracts are eco-friendly, possess structural diversity, complexity and are frequently impregnated with halogenated atoms (Duke *et al*., 2000). Presently, more than 200 species of plant pathogens are reported to be resistant to chemical pesticides (Varma and Dubey, 1999). Tandel *et al*. (2010) evaluated Phyto extracts of eleven plant

species against *M. phaseolina* of green gram and revealed that the onion bulb extract produced maximum inhibition (98.14%) followed by extractions of acacia, ginger, neem, garlic and karanj. A serious setback off these chemicals is environmental pollution that resulted in standby mode. Thus, there is an urgent need for the development of alternative disease control tactics that are effective coupled with eco-friendly nature. These Phyto extracts are cost effective, relatively safe for farmers who can't rely on synthetic pesticides. The present study was ascertained to investigate the anti-fungal activities of leaf extracts of various plant species and oil cake extracts, which are readily available, affordable and environmentally safe and mycelial growth of *R. solani in-vitro* condition.

MATERIALS AND METHODS

An experiment was carried out in the department of Plant Pathology, Faculty of Agriculture, Birsa Agricultural University, Ranchi, Jharkhand during Rabi 2014-15 and 2015-16 cropping season in *in-vitro* condition.

In-Vitro Evaluation of Plant Leaf Extracts Against R. Solani

Eight commonly available plant leaf extracts were used viz., neem *(Azadirachta indica)*, Karanj *(Pongamia pinnata)*, Bakain *(Melia Azadirachta)*, Datura *(Datura stramonium)*, Bael *(Aegle nameless)*, *Eucalyptus (Eucalyptus globulus)* and Marigold *(Tagetes erecta)* at 10 and 20 percent concentrations by using poison food technique.

Preparation of Aqueous Extracts

Fresh plant leaves were collected and washed first with tap water and then with distilled water. A hundred grams of fresh sample were chopped and then crushed in a surface sterilized pestle and mortar by adding 100ml sterile water (1:1 w/v). The extract was filtered through two layers of muslin cloth. Finally, filtrate thus obtained was used as a stock solution. This formed the standard plant extract solution (100%). The extracts of different plant leaves were incorporated and sterilized for 20 minutes. Ten and twenty ml of stock was mixed with 90 and 80 ml of sterilized molten PDA medium, respectively, so, as to get 10 and 20 percent concentration. The medium thoroughly shaken for uniform mixing of extracts and then after adding the botanical again the media was sterilized. Twenty ml of medium was poured into each of the 90mm sterile Petri plates. Each plate was inoculated with 5mm mycelial discs taken from the periphery of fungal culture and incubated at 25 ± 1° C. The experiment was arranged in a completely randomized design (CRD). Three replications were maintained for each treatment. The fungus grown on PDA without plant extracts served as control. Mean colony diameter in each case was recorded by taking the diameter, the colony in two directions. Radial growth of the fungus was measured after four and seven days of inoculation. The efficacy of plant extracts was expressed as percent of radial growth over the control, which was calculated by using the following formula (Vincent, 1947). The data were analyzed statistically:

$$I = \frac{(C-T)}{C} \times 100$$

Where,

I= percent inhibition

C= radial growth in control

T= radial growth in treatment

In-Vitro Evaluation of Different oil Cake Extracts against R. Solani

Nine oil cakes extract viz., Niger (*Carthamus tinctrorius*), Neem (*Azadirachta indica*), Soybean (*Glycine max*), Mustard (*Brassica compestris*), Linseed (*Linum usitatissimum*), Sesamum (*Sesamum indicum*), Karanj (*Pongamia pinnata*), Groundnut (*Arachis hypogaea*), Mahua (*Madhuca indica*) was collected and tested for their efficacy against *R. solani* by poisoned food technique. The oil cakes were first soaked in sterile distilled water at the rate of one gm. in one ml of water and kept overnight and the ground in pestle and mortar, by adding sterile water at the ratio of 1:1 (w/v). The macerate was squeezed using cotton to get the extract. The macerate was strained through two layers of muslin cloth and finally through Whatman No. 1 filter paper and this formed the standard plant extract solution (100%). This was further diluted with sterilized distilled water (v/v) to have the required concentrations (10 and 20%). The PDA medium was mixed with different concentrations viz., 10 and 20 % of oil cakes. Mycelium plug of the pathogen was placed at the centre of each petri plate and incubated at 25± 1º C. The growth of the diameter was recorded and percent inhibition was calculated.

RESULTS AND DISCUSSIONS

Anti-fungal activity of eight plant leaf extracts with different concentrations was assayed by using poisoned food technique. The colony diameter of the fungus was recorded after 4 and 7 days incubation at 25 ± 2º C and percent growth inhibition was calculated.

The results are presented in **Table 1, Plate 1 A, B and Figure 1** revealed that all the plant leaf extracts at both concentrations (10 and 20%) inhibited the mycelial growth significantly over the control. At 10% concentration, after 4 days incubation Neem leaf extracts *(A. Indicia)* (T_1) showed the lowest colony diameter of 20.33 mm and maximum mycelial growth inhibition of 66.87%, which was significantly superior over all other treatments. After 7 days of incubation, lowest colony diameter of 41.26 mm and maximum mycelial growth inhibition (54.14%) was observed by Neem leaf extract (T_1) followed by Bakain leaf extract (T_3) (24.62%), Karanj leaf extract (T_2) (18.69%) and Datura leaf extract (T_4) (11.44%). These treatments were significantly at par after 7 days incubation. The rest of the treatments in order of superiority were Baal, *Eucalyptus* and Sindwar, which were statistically at par with each other. Least inhibition of mycelial growth was recorded in Marigold leaf extracts (T_8) up to 16.56 and 4.89 percent after 4 and 7 days incubation, respectively

At 20% concentration after 4 days incubation, the minimum colony diameter (0.97 mm) and maximum mycelial growth inhibition 98.26 % was recorded in Neem leaf extract (T_1), followed by Bakain leaf extract (T_3) (80.31%), Karanj leaf extract (T_2) (66.26%), Bael leaf extract (T_5) (64.86%) and Datura leaf extract (T_4) (60.01). Treatment T_1 was significantly superior to all other treatments. Thus, treatment (T_1) Neem leaf extract was statistically at par with the treatment T_3 (Bakain leaf extract). The maximum colony diameter was recorded in the control (53.33 mm). After seven days incubation, minimum colony diameter (20.83 mm) and maximum growth inhibition (74.58%) was observed in Neem leaf extract (T_1) followed by Bakain leaf extract (T_3) (67.22%), Bael leaf extract (T_5) (55.92%), Datura leaf extract (T_4) (53.67%) and Karanj leaf extract (T_2) (54.97%). The minimum inhibition of mycelial growth was recorded by Marigold leaf extracts (T_8) up to 44.40 and 24.81 percent after 4 and 7 days incubation, respectively at 20% concentration (**Table 2, Plate 2, Figure 2**). The sclerotial production was nil in all the leaf extracts as well as in control after 4 and 7 days incubation.

These results are in conformity with Singh *et al.* (1980), who studied the fungitoxic properties of plant extract against *Rhizoctonia solani* and reported that *Azadirachta indica* suppress the formation of sclerotia of *Rhizoctonia solani* and inhibit the growth of mycelium by 53.6 percent, under laboratory condition. Neem leaf extract contains azadirachtin which show a toxic effect against *R. The salon* was also demonstrated by Shivapuri *et al.* (1997), Sidhan *et al.* (1999) and Sharma *et al*. (2005). Kane *et al.* (2002) reported that crude extract of *A. sativum, Eucalyptus* and *Z. Officinal* were effective in inhibiting the mycelial growth of *R. solani* to the extent of cent percent, Mishra *et al*. (2005) evaluated seven aqueous plant extracts (*Calotropis gigantean, Vinca rosea, Ocimum sanctum, A. Indicia, Eucalyptus citriodora, A. cepa* and *Z. Officinal)* against *R. solani* in green gram *in-vitro* and found that highest inhibitory action (86.11%) was recorded by *Z. Officinal*. Tiwari and Das (2011), who reported that plant extracts of *P. corylifolia, A. racemosus* and *C. forskohlii* were highly efficacious of the mycelial growth as well as in checking the disease severity of *Rhizoctonia solani* against sheath blight of rice. Hussain *et al*. (2014), Wadikar and Nimbalkar (2015) and Naik *et al.* (2016) evaluated the efficacy of four plants extracts *viz.*, Neem, *Pongamia, Subabul gliricidia* and observed the radial growth of the mycelium. Neem leaf extract found maximum inhibition (90 mm) of the fungus at 5, 10 and 15 percent concentration followed by *Pongamia* leaf extract at seven days after incubation. Among the leaf extract, neem and *Pongamia* leaf extracts were found to be effective against root rot pathogens, *R. solani*.

The extracts of nine oil cakes at different concentrations were evaluated for inhibitory effect on *R. solani.* The results presented in **Table 3** indicated that at 5% concentration, 4 days after incubation. Neem oil cake extract (T_2) showed a lowest colony diameter of 27.00mm and maximum mycelial growth inhibition of 64.15 percent which was significantly superior over all other treatments. This treatment was followed by Mustard oil cake extract (T_4) (55.82%), Karanj oil cake extract (T_7) (49.12%) and Niger oil cake extract (T_1) (37.40%). Minimum mycelial growth (21.66%) was recorded in Linseed oil cake extracts (T_5) followed by. Soybean oil cake extract (T_3) (24.63%), Sesamum oil cake extract (T_6) (26.54%), Groundnut oil cake extract (T_8) (27.86%) and Mahua oil cake extract (T_9) (28.76%). However, the control plate recorded colony diameter of 75.33 mm after 4 days incubation. The sclerotial production was nil in all the treatments as well as in control.

After 7 days incubation, at 5 % concentration, Neem oil cake extract (T_2) absorbed lowest colony diameter of 30.16mm and maximum mycelial growth inhibition of 66.48 percent. This treatment (T_2) was followed by Mustard oil cake extract (32.58%) and Karanj oil cake extract (T_7) (30.36%). The linseed oil cake extract showed no inhibition of mycelial growth at 10% concentration. The control plate recorded colony diameter of 90.00 mm. The sclerotial production was found in the treatment (T_9) (**Table 3, Plate 3 A, B Figure 3).** After 4 days incubation at 10% concentration, Neem oil cake extract (*Azadirachta indica*) (T_2) showed a lowest colony diameter of 10.50 mm and maximum mycelial growth inhibition of 81.84 percent. This treatment was followed by Mustard oil cake extract (T_4) (78.97%), Karanj oil cake extract (T_7) (72.47%), Mahua oil cake extract (T_9) (59.31%), Groundnut oil cake extract (T8) (51.62%) and Sesamum oil cake extract (T6) (51.11%). The minimum growth inhibition (28.17%) was recorded in the Linseed oil cake extract at 10 percent concentration. However, the control plate showed a maximum colony diameter of 57.83 mm.

After 7 days incubation, at 10 percent concentration, Neem oil cake extract (T_2) showed lowest colony diameter of 30.00 mm and maximum mycelial growth inhibition of 64.97 percent, which was followed by Mustard oil cake extract (T_4) (62.30%), Karanj oil cake extract (T_7) (61.30%) and Mahua oil cake extract ($T_{9)}$ (43.89%). The minimum of mycelial growth was observed in the Linseed oil cake extract (T_5) (26.07%). The radial growth of the control plate showed a

maximum colony diameter of 85.66 mm (T_{10}) **(Table 4, Plate 4 A, B and Figure 4).**

The findings in the present studies are in corroboration with those described earlier by other workers viz., Jha *et al* (2000), who reported that among oil cakes tested, *B. juncea* cake exhibited maximum inhibition of mycelial growth (51.8%) at 5% concentration against *Macrophomina phaseolina* causing root rot of okra. Sonali and Gupta (2004) reported that aqueous extract of mustard cake (5%), neem cake (1%), pine needles (5%), deodar needles (3%) and neem oil (3%), respectively leading to reduce *in-vitro* germination of sclerotia of test pathogen *S. rolfsii* Sacce, causing seedling blight disease in apple nurseries, as compared to control. Combination of mustard cake (5%) with neem oil (3%), neem cake (1%) with deodar needles (3%) and neem oil (3%) and mustard cake (5%) resulted total inhibition of sclerotia germination. Pan *et al*. (2009) reported that efficacy of mustard cake-wheat bran formulation of *T. harzianum* of test best product formulates against root rot disease of cabbage and collar rot of groundnut.

CONCLUSIONS

The difference between the effectiveness of plant extracts and oil cakes at different concentrations may be due to the presence of certain chemical substances in these leaf extracts and oil cakes. The chemical substances, which have an inhibitory effect, may be less at low concentration, but other substances, which were essential for fungal growth, may be present in sufficient amount. But, at higher concentration due to the enhancement of inhibitory chemical substances, growth supporting substances may be reduced. It is concluded that the neem leaf and oil cake extracts were found to be more effective in all the concentrations in inhibiting the mycelial growth of the test fungus *(R. solani)* up to 7 days, which was superior over control, and the rest of the leaf and oil cake extracts used during the course of investigation. Hence, these cost effective, eco-friendly natural products can be used as an alternative to hazardous fungicides.

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APPENDICES

Table 1: *In-Vitro* Evaluation of Different Plant Leaf Extracts on the Mycelial Growth Inhibition of *R. Solani* at 10% Concentration after 4 and 7 Days Incubation

Treatments	Concentration (%)	After 4 Days		After7 Days		Sclerotial Production
		Colony Diameter (mm)	Growth Inhibition (%)	Colony Diameter (mm)	Growth Inhibition (%)	
T1- Neem leaf extract(*Azadirachta indica*)	10	20.33	66.87	41.26	54.15	NIL
T2- Karanj leaf extract(*Pongamia pinnata*)	10	40.66	33.73	73.16	18.69	NIL
T3- Bakain leaf extract (*Melia azadirachta*)	10	30.83	49.73	67.66	24.62	NIL

Table 1: Contd.,						
T4- Datura leaf extract(*Datura stramonium*)	10	44.33	27.71	52.96	11.44	NIL
T5- Bael leaf extract (*Aegle marmelos*)	10	36.50	40.49	82.73	8.07	NIL
T6- Eucalyptus leaf extract (*Eucalyptus obliqua*)	10	47.33	22.83	82.36	8.48	NIL
T7- Sindwar leaf extract(*Vitex negunda*)	10	48.83	20.38	84.50	6.11	NIL
T8- Marigold leaf extract(*Tagetes erecta*)	10	51.16	16.56	85.60	4.89	NIL
T9- Control-	-	61.33	-	90.00	-	Yes
SEm ±		1.021		3.111		
CD 5%		3.058		9.316		
CV %		4.175		7.124		

*Average of three replications

Table 2: *In-vitro* Evaluation of Different Plant Leaf Extracts on the Inhibition of Mycelia Growth of *R. Solani* at 20% Concentration after 4 and 7 Days Incubation

Treatments	Concentration (%)	After 4 days		After7 days		Sclerotial Production
		Colony Diameter (mm)	Growth Inhibition (%)	Colony Diameter (mm)	Growth Inhibition (%)	
T1- Neem leaf extract (*Azadirachta indica*)	20	0.97	98.17	20.83	74.58	NIL
T2- Karanj leaf extract (*Pongamia pinnata)*	20	18.00	66.26	36.63	54.97	NIL
T3- Bakain leaf extract (*Melia azadirachta*)	20	10.50	80.31	26.63	67.22	NIL
T4- Datura leaf extract (*Datura stramonium*)	20	21.33	60.01	37.66	53.71	NIL
T5- Bael leaf extract (*Aegle mormelos*)	20	18.73	64.86	35.83	55.92	NIL
T6- Eucalyptus leaf extract (*Eucalyptus obliqua*)	20	22.16	58.45	43.43	46.61	NIL
T7- Sindwar leaf extracts (*Vitex negunda*)	20	25.26	52.60	49.66	38.92	NIL
T8- Marigold leaf extracts (*Tagetes erecta*)	20	29.66	44.40	61.16	24.81	NIL
T9- Control	-	53.33	-	81.36	-	-
SEm ±		0.663		0.757		
CD 5%		1.985		2.266		
CV %		5.128		3.000		

*Average of three replications

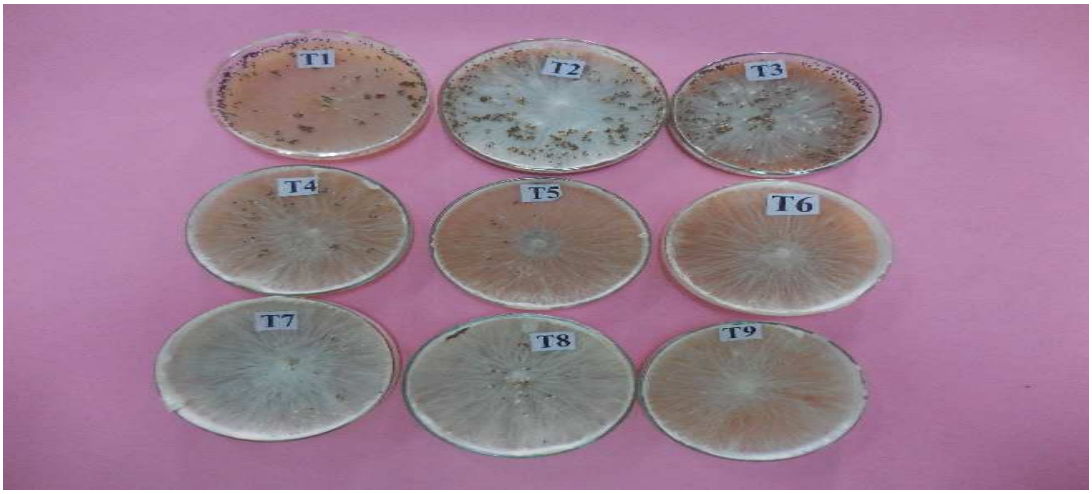
In-Vitro **Evaluation of Different Plant leaf Extracts on the Inhibition of Mycelial Growth of *R. Solani* at 10% Concentration after 4 Days Incubation**

Plate 1 A

T1- Neem, T2- Karanj, T3- Bakain, T4- Datura, T5- Bael, T6- Eucalyptus, T7- Sindwar, T8- Marigold, T9- Control

In-Vitro **Evaluation of Different Plant leaf Extracts on the Inhibition ofMycelial Growth of *R. Solani* at 10% Concentration after 7 Days Incubation**

Plate 1 B

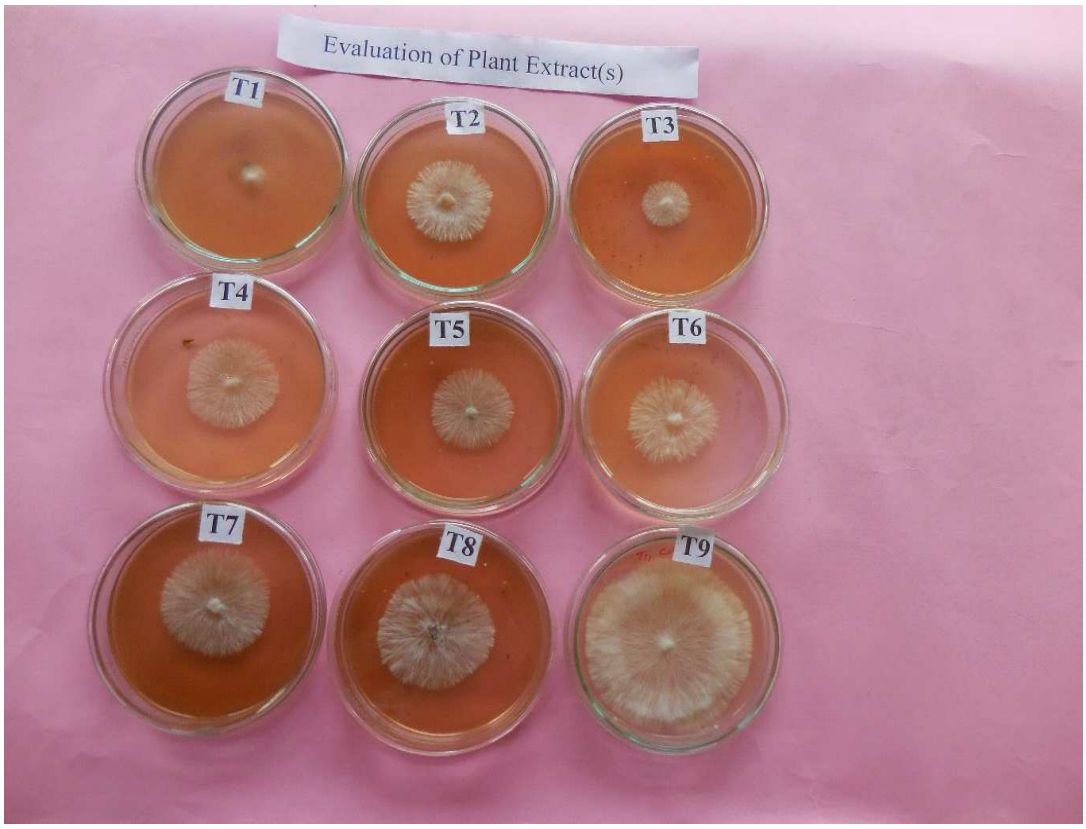


T1- Neem, T2- Karanj, T3- Bakain, T4- Datura, T5- Bael, T6- Eucalyptus, T7- Sindwar, T8- Marigold, T9- Control

Figure 1: *In-Vitro* Evaluation of Different Plant Leaf Extracts on the Inhibition of Mycelial Growth of *R. Solani* at 10% Concentration after 4 and 7 Days Incubation

***In-vitro* evaluation of different plant leaf extracts on the inhibition of mycelial growth of *R. solani* at 20% concentration after 4 days incubation**

Plate 2



T1- Neem leaf extract, T2- Karanj leaf extract, T3- Bakain leaf extract, T4- Datura leaf extract, T5- Bael leaf extract, T6- Eucalyptus leaf extract, T7- Sindwar leaf extract, T8- Marigold leaf extract, T9- Control

Figure 2: In-Vitro Evaluation of Different Plant Leaf Extracts on the Inhibition of Mycelial Growth of R. Solani at 20% Concentration after 4 Days Incubation

Table 3: *In-Vitro* Evaluation of Different Oil Cake Extracts on the Inhibition of Mycelial Growth of *R. Solani* at 5 % Concentration after 4 and 7 Days Incubation

Treatments	Concentration (%)	After 4 days		After7 days		Sclerotial Production
		Colony* Diameter (mm)	Growth Inhibition (%)	Colony Diameter (mm)	Growth Inhibition (%)	
T1-Niger cake extract (*Carthanus tinctrorius*)	5	47.16	37.40	81.50	09.25	NIL
T2-Neem cake extract (*Azadirachta indica*)	5	27.00	64.15	30.16	66.48	NIL
T3-Soyabean cake extract (*Glycine max*)	5	56.00	24.63	86.66	05.55	NIL
T4-Mustard cake extract (*Brassica compestris*)	5	32.06	55.82	60.66	32.58	NIL
T5-Linseed cake extract (*Linum usitatissimum*)	5	59.00	21.66	90.00	0.00	NIL
T6-Sesamum cake extract (*Sesamum indicum*)	5	55.33	26.54	89.00	01.11	NIL

Table 3: Contd.,						
T7-Karanj cake extract (*Pongamia pinnata*)	5	30.50	49.12	62.66	30.36	NIL
T8-Groundnut cake extract (*Arachis hypogaea*)	5	54.33	27.86	86.33	04.07	NIL
T9-Mahua cake extract (*Madhuca indica*)	-	53.66	28.76	85.33	05.18	Yes
T10-Control-		75.33	-	90.00		
SEm ±		0.976		1.300		
CD at 5%		2.900		3.861		
C.V. %		3.573		3.081		

* Mean of three replications

***In-Vitro* Evaluation of different Oil Cake Extracts on the Inhibition of Mycelial Growth of *R. Solani* after 4 Days Incubation at 5 % Concentration**

Plate 3 A

T1-Niger cake, T2-Neem cake, T3-Soybean cake, T4-Mustard cake, T5-Linseed cake, T6-Sesamum cake, T7-Karanj cake, T8-Groundnut cake, T9-Mahua cake, T10-Control

***In-Vitro* Evaluation of Different oil Cake Extracts on the Mycelial Growth Inhibition of *R. Solani* after 7 Days Incubation at 5 % Concentration**

Plate 3 B

T1-Niger cake, T2-Neem cake, T3-Soybean cake, T4-Mustard cake, T5-Linseed cake, T6-Sesamum cake, T7-Karanj cake, T8-Groundnut cake, T9-Mahua cake, T10-Control

Figure 3: *In-Vitro* Evaluation of Different Oil Cake Extracts on the Inhibition of Mycelial Growth of *R. Solani* at 5 % Concentration after 4 and 7 Days Incubation

Table 4: *In Vitro* Evaluation of different Oil Cakes Extracts on the Myceial Growth Inhibition of *R. Solani* of French Bean at 10% Concentration After 4 and 7 Days Incubation

Treatments	Concentration (%)	After 4 Days		After7 Days		Sclerotial Production
		Colony Diameter (mm)	Growth Inhibition (%)	Colony Diameter (mm)	Growth Inhibition (%)	
T1-Niger cake extract (*Carthamus tinctrorius*)	10	34.66	40.07	59.00	31.11	NIL
T2-Neem cake extract (*Azadirachta indica*)	10	10.50	81.84	30.00	64.97	NIL
T3-Soyabean cake extract (*Glycine max*)	10	38.83	32.85	60.60	29.25	NIL
T4-Mustard cake extract (*Brassica compestris*)	10	11.83	78.97	32.30	62.30	NIL
T5-Linseed cake extract (*Linum usitatissimum*)	10	41.53	28.17	63.33	26.07	NIL
T6-Sesamum cake extract (*Sesamum indicum*)	10	28.26	51.11	56.73	33.77	NIL
T7-Karanj cake extract (*Pongamia pinnata*)	10	15.93	72.47	33.16	61.30	NIL
T8-Groundnut cake extract (*Arachis hypogaea*)	10	28.00	51.62	53.83	37.16	NIL
T9-Mahua cake extract (*Madhuca indica*)	10	23.53	59.31	48.06	43.89	NIL
T10-Control-	-	57.83	-	85.66	-	YES
SEm ±		0.717		0.819		
CD at 5%		2.130		2.433		
C.V. %		4.425		2.879		

* Mean of three replications

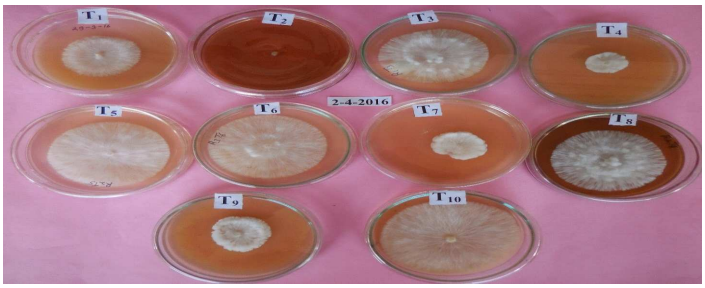
***In Vitro* Evaluation of Different oil Cake Extracts on the Inhibition of Mycelial Growth of *R. Solani* at 10% Concentration after 4 Days Incubation**

Plate 4 A

T1-Niger cake, T2-Neem cake, T3-Soybean cake, T4-Mustard cake, T5-Linseed cake, T6-Sesamum cake, T7-Karanj cake, T8-Groundnut cake, T9-Mahua cake, T10-Control

***In Vitro* Evaluation of Different Oil Cake Extracts on the Inhibition of Mycelial Growth of *R. Solani* at 10% Concentration After 7 Days Incubation**

Plate 4 B



T1-Niger cake, T2-Neem cake, T3-Soybean cake, T4-Mustard cake, T5-Linseed cake, T6- Sesamum cake, T7-Karanj cake, T8-Groundnut cake, T9-Mahua cake, T10-Control

Figure 4: *In Vitro* Evaluation of Different Oil Cake Extracts on the Inhibition of mycelial Growth of *R. Solani* at 10% Concentration after 4 and 7 Days Incubation